Evaluation of PM $_{2.5}$ Concentrations Across the Ohio River Valley

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The NETL-OST in-house $PM_{2.5}$ Site Sampling and Analysis program performs in-depth research to characterize ambient air concentrations of particulate matter with an aerodynamic diameter of 2.5 micrometers or less ($PM_{2.5}$). In particular this research program is directed toward determining the method and degree by which fossil-fuel-fired electric power generating stations contribute to the primary particulate matter load in ambient air. During the time period from October 1999 through September 2000, $PM_{2.5}$ mass and composition were measured daily at the NETL with two batch samplers, a $PM_{2.5}$ R&P Partisol®- Plus FRM and a BYU PC-BOSS, and continuously with a TEOM® monitor. The composition and concentrations of $PM_{2.5}$ were both highly variable during this time period.

Continuous $PM_{2.5}$ measurements were also obtained by various investigators with TEOM monitors taken in the Pittsburgh, Pennsylvania area, and at sites in Ohio including Steubenville, Columbus, and Athens during 1999 through 2000 . The PM data from the east and west sides of the Ohio River Valley were analyzed on high PM days . A temporal correlation was observed in the analysis of PM_{10} and $PM_{2.5}$ TEOM particulate mass data gathered from sites throughout the region. The correlation was particularly strong when comparing episodic events of high PM concentration. This relationship can be explained in terms of PM being transported into the region from significant sources outside of the region via meteorological events.

High fine particulate material concentration in the region were generally associated with transitions from locally high pressure to lower pressure. The concentrations of fine particulate mass during the high pressure periods were generally low throughout the study region. In addition, following an episode, as the pressure increased, the concentrations of PM often sharply decreased at all sites. This indicates that the pollution associated with the PM episodes did not originate from the local region around the various TEOM monitor sites but were transported into the area during the transition from a high to a lower pressure regime.

Further details related to this transport obtained from surface weather maps and estimated back-trajectories using the HYSPLIT model associated with these time periods. These analyses indicated that transport of pollutants to the NETL site was generally from the west to southwest. Similar conditions were observed at each of the $PM_{2.5}$ urban and regional sites included in this study. All sites showed a high correlation in the temporal patterns revealing homogeneity in the spatial concentrations across the Ohio River Valley during these days. Cluster analysis of back trajectories on these episodes indicate that the Ohio River valley acts as a significant source region of PM and its precursors.

The great majority of the episodes were described by flow from the southwest, including transport from the Ohio River Valley region from Marietta OH through Ashland WV. During these time periods, concentrations seen at various locations around the Pittsburgh urban area indicated that this regional transported fine particulate material generally dominated the PM in the urban area, including at sites downwind of the Pittsburgh urban plume. Concentrations at such diverse sites as the NETL site in Pittsburgh, Kittanning PA, Athens OH and Holbrook PA were comparable during these time periods. An alternative transport condition occurred when the flow to Athens was from further to the west, a region with fewer point source emissions. During these time periods, concentrations of $PM_{2.5}$ were generally lower at Athens during the episode.

The second most common transport condition was when transport at the NETL site was directly from the west, rather than from the southwest. Under these conditions, NETL would be expected to be influenced by emissions from the Steubenville region along the Ohio River Valley. This transport condition resulted in comparable concentrations and peak times at NETL and Holbrook, but frequently gave significantly lower $PM_{2.5}$ concentrations at Kittanning, north of Pittsburgh. Likewise, the westerly flows resulted in air masses present at the Athens OH site to have originated west of Athens (generally south of Columbus and north of Cincinnati, OH) and $PM_{2.5}$ concentrations at Athens were low, consistent with expectations.